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THE KOREAN SNAKES OF THE GENUS *AGKISTRODON* (CROTALIDAE)

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For more than a century there has been confusion in the systematics of the Asiatic forms of *Agkistrodon* embraced by the *halys-intermedius-blomhoffii* complex within this genus. The publications of early typological taxonomists which have included descriptions of these snakes are in the main of little use at the present time. Some of the deficiencies of the early literature are due to limited material, unfortunate choice of diagnostic characters, failure to take into consideration the obvious sexual dimorphism in series of specimens, and neglect of the taxonomic importance of color patterns. Ecological knowledge was mostly nonexistent and the concept of the biological species had not yet developed. In more recent times, workers unable to use the Russian language at first hand found the important systematic works of such notable investigators as A. M. Nikol'skii, A. A. Emelianov, and S. C. Chernov difficult of access.

It is unlikely that any single investigator will be in a position to analyze thoroughly all populations of the species and subspecies of *Agkistrodon* that surely exist in the vast expanse of Central Asia from the Caspian Sea to Japan. Advances in the bionomics of this group of snakes will necessarily proceed slowly and piecemeal, and ultimately we must look to colleagues in Europe and Asia for definitive studies. Some of the problems, however, can be separated, examined, and to some extent clarified, and an effort in this direction is the object of this preliminary paper dealing with Korea and adjacent areas —southern Manchuria and the eastern Khabarovsk region, U.S.S.R.

The forms involved appear variously in the literature under the following names: 1) *halys* Pallas, 1776; 2) *blomhoffii* Boie, 1826; 3) *intermedius* Strauch, 1868; 4) *brevicaudus* Stejneger, 1907; 5) *ussuriensis* Emelianov, 1929; 6) *stejnegeri* Rendahl, 1933; 7) *saxatilis* Emelianov, 1937.

The principal source of confusion, and the most troublesome, has been Strauch's *intermedius*, apparently a composite from the very beginning and certainly a composite in the subsequent literature and in the labeling of specimens in museum collections. This name seems to have provided a convenient residuum for any and all specimens not definitely assignable to taxa more satisfactorily defined.

The great variation in specimens from Korea has been frequently remarked. For the most part, if subspecific names were used, these specimens have been listed both in the literature and in museum catalogs under the name *brevicaudus*. This was partly because differences in coloration are less conspicuous in preserved specimens and partly because not enough material has been assembled at one time and in one place to provide a comprehensive picture of the several components of the group. The problems have become less difficult, however, with the accumulation of specimens recently collected by various members of the American armed forces in Korea during, and subsequent to, the 1950's. Among those who have helped in this way and who should receive special mention are James R. Dixon, J. Knox Jones, Jr., the late Frederick A. Shannon, Donald Daleske, Donald E. Hahn, and James Hanlon, Jr. Some of them have published on their collections (see Literature Cited) and some have provided me with additional unpublished data.

Through the courtesy of Roger Conant I was able to examine a number of live specimens given to the Philadelphia Zoo by James Hanlon, Jr. This good fortune helped me to clarify some puzzling obscurities not easily resolved by means of preserved material alone.

On the basis of 150 specimens from Korea and adjacent areas, I find three recognizable forms of *Agkistrodon*: two already named, *A. blomhoffii brevicaudus* Stejneger and *A. saxatilis* Emelianov, and a third described below. Useful

ecological data are scanty and precise localities are lacking for some specimens. These three forms are cryptic species, sympatric in several areas (Kaesong, Seoul, and others), but once diagnosed the great majority of specimens can be easily discriminated on characters of coloration, scutellation, body form and proportions. An apparently disjunct population in mainland China, referred to in the literature as *brevicaudus*, is not discussed in this paper but is reserved for consideration after further analysis of material from China and Central Asia. The three species diagnosed here will be treated in greater detail in a future review of the entire genus.

Shannon (1956) has correctly pointed out that Korean place names are difficult and exceedingly frustrating. Transliterations vary, political changes have been frequent, and in many cases the same spelling of a name applies to two or more different towns or villages. Gazetteers and maps issued by the U.S. Army Map Service have been of paramount usefulness, and I have had expert assistance from the map librarians of the University of Arizona Library. For names of provinces and cities of provincial status I have followed Department of the Army Pamphlets 550-11 and 550-41 and The International Atlas, Rand McNally, 1969. Shannon's list of localities (loc. cit.) has been helpful, although I have found it necessary to differ from it in some cases. The gazetteer included by Webb et al. (1962) is excellent for the localities involved in their study. Despite great care and diligence, it is likely that some of the localities listed here are incorrectly placed. In any case, the maps show only approximate areas from which the material studied is said to have come.

Thompson (1916), Hahn (1960), and others have indicated need for caution in accepting all place names at face value, pointing out that in countries of the Far East and elsewhere various snakes, and particularly "mamushis,"* are commonly sold in commercial shops for gastronomic and medicinal purposes. It is highly probable, therefore, that specimens from such sources commonly find their way into museum collections, and that their stated localities at best are only approximate.

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* The Japanese name "mamushi" is commonly applied to any or all snakes of the *halys-intermedius-blomhoffii* complex in both Japanese and Russian literature.

Abbreviations used in text for museums and private collections: AMNH—American Museum of Natural History, New York. BMNH—British Museum (Natural History), London. BYU—Brigham Young University, Provo, Utah. CAS—California Academy of Sciences, San Francisco. FMNH—Field Museum of Natural History, Chicago. Hahn—Donald E. Hahn, Cottonwood, Arizona. KU—University of Kansas Museum of Natural History, Lawrence. LACM—Los Angeles County Natural History Museum, California. MVZ—Museum of Vertebrate Zoology, University of California, Berkeley. NMW—Naturhistorisches Museum, Wien, Austria. TNHC—Texas Natural History Collection, University of Texas, Austin. UIMNH—University of Illinois Museum of Natural History, Urbana. UMMZ—University of Michigan Museum of Zoology, Ann Arbor. USNM—National Museum of Natural History, Washington, D.C.

Agkistrodon blomhoffii brevicaudus Stejneger

Short-tailed Mamushi
Figure 1

Agkistrodon blomhoffii brevicaudus Stejneger, 1907, p. 463.—Thompson, 1916, p. 62 (part).—Slevin, 1925, p. 99 (part).

Ancistrodon halys brevicaudus.—Nikol'skii, 1916, p. 283 (part); 1964 [translation], p. 191 (part).—Rendahl, 1933, p. 21 (part).—Shannon, 1956, p. 47 (part).

Agkistrodon halys brevicaudus.—Stejneger, 1925, p. 97 (part).—Sowerby, 1930, p. 22 (part).—Maki, 1931, p. 206 (part), fig. 138 A, 139.—Hahn, 1960, p. 21.—Webb et al., 1962, p. 170 (part).—Klemmer, 1963, p. 399 (part).

Ancistrodon blomhoffi brevicaudus.—Terent'ev and Chernov, 1949, p. 277 (part); 1965 [translation], p. 255 (part).

This form is here regarded as a subspecies of *A. blomhoffii* Boie, 1826, type-locality Japan, which in my view is separable from *A. halys* Pallas, 1776, and which has other subspecies in China, Japan, and the Far East.

In naming *brevicaudus*, Stejneger (1907) diagnosed the subspecies on a minimum of data and stated that no detailed description was thought necessary because of its similarity to the typical *A. blomhoffii* of Japan. Apparently he did not check the sexes of his specimens by dissection. In addition to the holotype, a female, the Korean individuals before him were USNM 14612, 14613, and 17508, and UMMZ 30525 ("young"), all females. He mentioned the uniform black bellies of the four adult specimens, but made no comment on the different coloration and the higher number of ventrals and subcaudals of the "young" one (which is

Fig. 1. *Agkistrodon blomhoffii brevicaudus* Stejneger, vicinity of Seoul, South Korea. AMNH 108499.

now referable to the form here described as new). At that time also he had specimens from China in mind, and he mentioned others supposedly from Hainan and Formosa, which localities are now thought to be erroneous. A redefinition of *brevicaudus*, entirely on the basis of Korean material, is necessary in order to distinguish it from the other two forms of the region. Variation of meristic characters is shown in Tables 1–3 and Figures 5 and 6 where all three forms are compared.

Type-locality: Fusan (= Pusan), South Korea; holotype USNM 17507, female, collected by P. L. Jouy, 1885.

Diagnosis: Body with a conspicuous pattern of subelliptical blotches (or half-bands) on a light brown or gray ground color; blotches brown, lighter at their center but with dark brown borders, opposite or alternating pairs meeting dorsally at midline or not in contact at all, 3–5 scales wide on sides and extending downward onto scale rows 3 or 2; number of half-bands 23–33 (28.9) in males, 25–36 (30.8) in females (Table 1).

Table 1. Variation in number of half-bands or crossbands of body

	Males			Females		
	N	Range	Mean	N	Range	Mean
brevicaudus	24	23–33	28.9	32	25–36	30.8
caliginosus	25	23–33	27.6	41	22–31	27.4
saxatilis	16	30–42	38.3	4	29–44	39.0

Table 2. Variation in number of ventrals and subcaudals

	Males				Females			
Ventrals	N	Range	Mean	SE	N	Range	Mean	SE
brevicaudus	25	135–145	138.9	.519	31	140–149	143.2	.439
caliginosus	34	139–153	146.8	.605	41	143–155	148.0	.443
saxatilis	37	149–164	154.4	.618	23	148–165	159.2	.852
Subcaudals								
brevicaudus	24	35–44	40.5	.416	33	30–38	34.9	.317
caliginosus	32	40–52	46.8	.533	42	36–48	42.2	.350
saxatilis	34	37–48	41.6	.452	21	34–41	37.4	.434

Belly black or nearly so, especially posteriorly, lighter laterally; crown and parietal region with conspicuous dark brown markings and a lyriform figure extending backward on neck; cheek stripe strong, dark reddish brown in life, sharply bordered above and below with white, the upper light line extending across top of eye; tongue black; tip of tail light—yellow in life.

Internasals wider than long, the posterior margins curving obliquely backward from midline; loreals subquadrate, as high as wide; preoculars 2; postoculars 2 (60%) or 3, the lowest extending forward beneath the eye; supralabials 7 (95%), rarely 8; infralabials 10 (75%), occasionally 9 or 11; posterior supralabials not conspicuously low and narrow. Scale rows 21 at midbody, all with keels posteriorly, lowest without keels anteriorly; paired apical pits present but inconspicuous. Ventrals 135–145 (138.9) in males, 140–149 (143.2) in females; subcaudals 35–44 (40.5) in males, 30–38 (34.9) in females (Table 2).

Size and form: Adult body form relatively stout, head broad, and tail short. Tail in males 12–15 (13.5) percent of total length, in females 11–13 (11.7) percent (Table 3). The largest male examined is UIMNH 68750, Kumhwa, 710 mm in total length, tail 90 mm; largest female, FMNH 188974, Chorwon, 680 mm, tail 82 mm. Juveniles 173–217 mm.

Habitat: Hahn's specimen from Tong-du-Chon (1960, p. 21) was found "at dusk near a building in a low grassy area in a valley." In a

Table 3. Relative length of tail—in percentage

	Males			Females		
	N	Range	Mean	N	Range	Mean
brevicaudus	16	12–15	13.5	18	11–13	11.7
caliginosus	19	15–17	15.8	34	12–15	14.0
saxatilis	10	11–14	13.0	4	11–12	11.2

personal communication Daleske, apparently with reference to both of two different forms, stated that in the vicinity of Munsan-ni he found these snakes on brushy, hillside slopes of second-growth pine-oak woodland with sandy loam soil and talus outcroppings. See further comment, p. 566.

Range: Korea, Masan-Pusan area in the south and northward into South Manchuria (Yalu River). Map 1.

Specimens examined: KOREA: Ch'ungch'ong-namdo Province—Chiksan, CAS 31523. Songwan-ni, TNHC 18437–8. Tongjin, Kimpo Peninsula, LACM 3130. Ch'ungch'ong-pukto Province—Pass between Sanju and Ch'ungju, FMNH 67118. Kaesong City—Songdo (= Kaesong), FMNH 11474, 25238. Kaesong (14 mi. E), FMNH 188972–3. Kangwon-do Province—Chorwon (8 mi. S), UIMNH 68754; (8 mi. W), FMNH 188974–85. Hongchon (5 mi. S), FMNH 67119; (1½ mi. NW), FMNH 67120. Kumhwa (23 mi. S), UIMNH 68750. Wonsan, CAS 31508. Kyonggi-do Province—Chipo-ri, USNM 132859; (3 mi. NW), KU 38804 (2). Kapyong, USNM 132455, UIMNH 68751; (4 mi. W), UIMNH 68752. Korangpo-ri, USNM 137276. Munsan-ni, TNHC 18441; (9–11 mi. NE), FMNH 188971. Songu-ri, USNM 132894. Tong-du-Chong (45 mi. NE Seoul), Hahn 1785. Uijongbu (2 mi. N), FMNH 188986–90. 40 mi. NE Seoul, UIMNH 68753. Kyongsang-namdo Province—Masan, TNHC 16183. Kyongsang-pukto Province—Andong, TNHC 18440. Yongchon (7 mi. NW), USNM 132352. Pusan City—Fusan (= Pusan), USNM 17507 [type]. Seoul City—Seoul, AMNH 180495–500; (7 mi. SE), BYU 11452; (7 mi. ESE), KU 38800; (6 mi. E), KU 38798–9; (5 mi. E), UMMZ 113464.

SOUTH MANCHURIA: Yalu River, about 180 mi. above mouth, USNM 52341 (Sowerby).

Agkistrodon caliginosus new species

Caliginous Mamushi

Figure 2

Agkistrodon blomhoffii brevicaudus Stejneger, 1907, p. 463 (part).—Slevin, 1925, p. 99 (part).

Ancistrodon halys.—Thompson, 1916, p. 62 (part).

Agkistrodon halys brevicaudus.—Stejneger, 1925, p. 97 (part).—Stewart, 1954, p. 67.—Webb et al., 1962, p. 170 (part).

Ancistrodon halys brevicaudus.—Shannon, 1956, p. 47 (part).—Dixon, 1956, p. 56 (not part).

Stejneger was puzzled by specimens representative of this form. When he described *brevicaudus* from Korea (1907, p. 464) he listed UMMZ 30525 (locality indefinite) with his types, recorded its larger number of ventrals and subcaudals, considered it "young" (total length 335 mm), but made no other comment. When he reported additional material (1925, p. 98) he remarked on the difference between two specimens

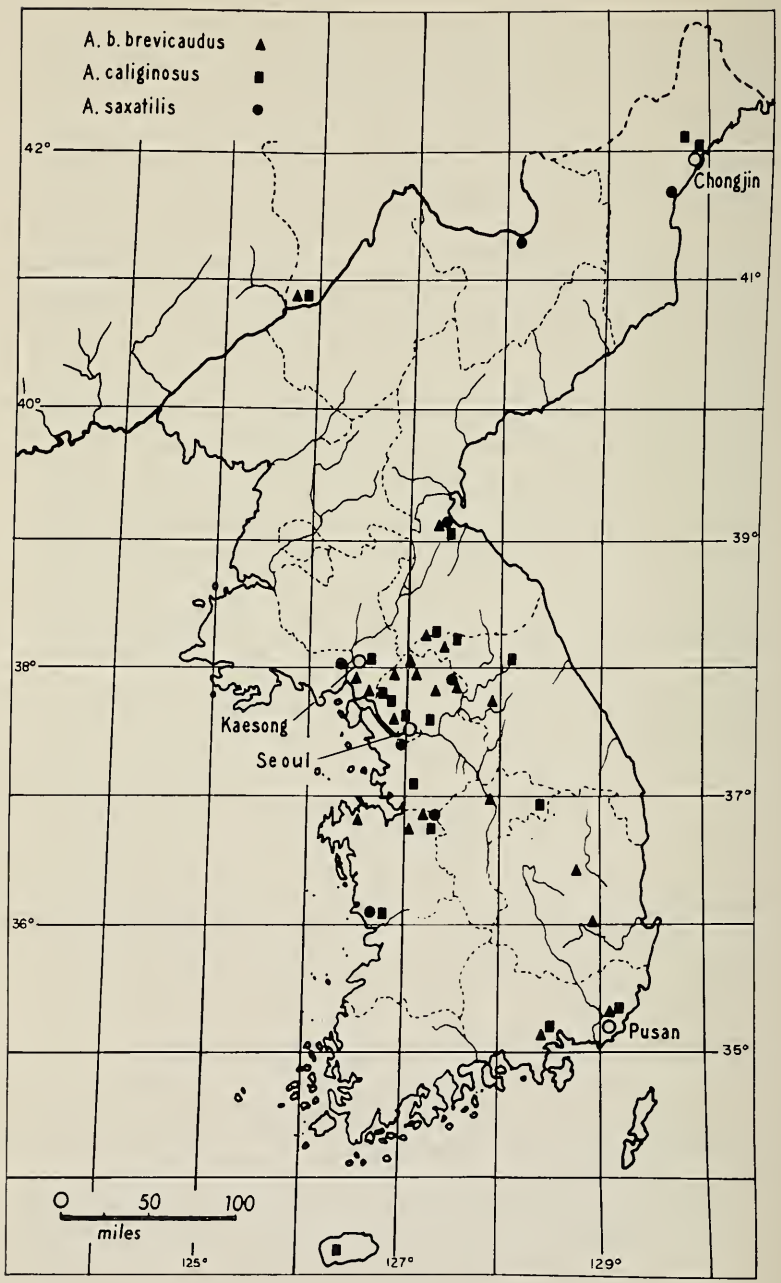
A. b. brevicaudus
A. caliginosus
A. saxatilis
42°
41°
40°
39°
38°
37°
36°
35°
Chongjin
Kaesong
Seoul
Pusan
0 50 100
miles
125°
127°
129°

Fig. 2. *Agkistrodon caliginosus* new species, type-specimen, vicinity of Seoul, South Korea. AMNH 108508.

collected by Sowerby on the Yalu River in South Manchuria: one with 143 ventrals and 41 subcaudals (USNM 52341) he considered to be ". . . well within the limits of *A. brevicaudus*. But the other one [USNM 52339, here referred to *caliginosus*], which it would be absurd to refer to under a different subspecific name, has 151 ventrals and 44 subcaudals. . . . I have no hesitancy in calling it *A. brevicaudus*, the decisive factor of course being the fact that its companion is typical of this form. Were it not for these dubious intermediate specimens in the geographically intermediate territory we would be justified in applying a binomial appellation rather than the present trinomial."

Holotype: American Museum of Natural History 108508, adult female, from vicinity of Seoul, South Korea, spring of 1966, James Hanlon, Jr.*

Paratypes: CAS 87048–54, 3–7 mi. SE Munsan-ni, Kyonggi-do Province, South Korea, 4–31 May 1952, James R. Dixon; KU 38801–4, Central

* In spite of lack of a more precise locality, this specimen was selected as the type because it was received alive and could be described in detail, photographed, and properly preserved. The name *caliginosus* refers to the generally dark coloration.

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Map 1. Approximate locations of places from which the specimens studied are said to have come. Triangles refer to *A. b. brevicaudus*, rectangles to *caliginosus*, and solid circles to *saxatilis*.

National Forest, near Pup-yong-ni, 125 m, Kyonggi-do Province, South Korea, 29 July–23 October 1954, J. Knox Jones, Jr.; FMNH 11470–1, 11475, 11478, 11485, 11487, Songdo Higher Common School, Songdo (= Kaesong), North Korea, 1930, L. H. Snyder.

Diagnosis: General coloration dark gray or dark brown with little contrast between pattern and ground color; pattern of dark-edged subquadrangular crossbands, 4–6 scales wide, extending down each side to scale row 2, and numbering 23–33 (27.6) in males, 22–31 (27.4) in females (Table 1). Belly dark, heavily pigmented, or almost totally black; crown without conspicuous markings; cheek stripe brown, bordered above and below by narrow white lines, the upper extending across top of eye; tongue pink in life; tip of tail and terminal spine dark, sometimes lighter ventrally.

Internasals wide and narrow, posterior margins curving obliquely backward from midline; loreals subrectangular, notably wider than high; preoculars 2; postoculars 2 (97%), upper small, lower crescent shaped and extending beneath eye; lower postocular rarely divided; supralabials 7 (94%), rarely 6 or 8, posterior supralabials not conspicuously low and narrow; infralabials 10 (75%), occasionally 9 or 11.

Scale rows 21 at midbody, all with keels posteriorly, paired apical pits present, inconspicuous. Ventrals 139–153 (146.8) in males, 143–155 (148.0) in females; subcaudals 40–52 (46.8) in males, 36–48 (42.2) in females (Table 2).

Description of holotype: Top of head (crown) with nine symmetrically arranged scutes characteristic of genus. Internasals wider than long, extending obliquely backward and in contact dorsolaterally with loreals. Rostral slightly wider than high, broadly truncate above. No aberrations in frontal, prefrontals, supraoculars, or parietals. Nasals two on each side, the anterior one about three times larger than the posterior, nostril in suture between. Loreals one on each side, relatively small, wider than high, in direct contact with large prefoveals. Preoculars two on each side, the upper one extending anteriorly over the edge of the canthus, the lower forming the upper posterior border of the pit. Postoculars two, the upper one small, in contact with the supraocular; the lower one crescent shaped, extending around the orbit laterally and ventrally, and making contact with the upper tip of the third supralabial. A small postfoveal below the lower preocular, making a total of seven scales surrounding the eye. Pit bordered by a large prefoveal anteriorly, a narrow subfoveal, and the lower preocular. Supralabials seven on each side, the third largest and its upper margin entering the orbit. Infralabials 10 on the left side, nine on the right. Temporals of lowest (first horizontal) row consist of three large, smooth scales, the anterior one largest, the remaining two about equal in size; temporals of second row composed of four smooth scales slightly larger than those above. First infralabials with pointed tips extending backward and in contact behind the posterior tip of the mental. One pair of chin shields, each slightly longer than

wide. Median gulars small, in two pairs followed by three transverse rows of three, four, and four scales each. Lateral gulars in two to four oblique rows.

Dorsal scales all strongly keeled on body and tail. Paired apical pits not discernible superficially but visible when individual scales are examined under magnification. Scale rows 23–21–19–17, the order of reduction as follows:*

$$23\ \frac{-5\ (17)}{4+5\ (18)}\ 21\ \frac{-4\ (100)}{-4\ (97)}\ 19\ \frac{-4\ (118)}{-4\ (115)}\ 17\ (148)$$

Ventrals 148, anal plate not divided. Subcaudals 41, all divided; terminal scute sharply pointed.

Total length 570 mm; tail length 78 mm; tail 13.5 percent of total length.

General coloration in life dark olivaceous gray to black above and below. Tongue conspicuously pink. Eye bicolored: upper portion of iris light brown, a continuation of the upper light line on the side of the head; lower portion dark reddish brown.

Dorsal pattern of head indistinct; irregular spots and flecks of dark brown and olive on scutes of crown; paraparietal region and posterior sides of head dark with a lighter area at middle, suggesting a pair of broad stripes but not a distinct figure; rostral and sides of snout salmon colored with fine gray and red stippling but no distinct markings; cheek stripe dark reddish brown with gray stippling, narrowly edged with white below, extending backward from orbit on upper edges of supralabials 4 to 7, across large temporals of first row and lower edges of temporals of second row; a sharp narrow line of brownish yellow extending backward across eye and from upper postocular across the four temporals of second row; supralabials flesh or salmon colored with gray stippling; infralabials with lighter centers, dark brown lower edges, and peripheral stippling; gulars profusely stippled with dark gray and black.

Dorsal pattern of body consisting of a series of dark crossbands, 28 in number, with borders of dark gray to black about one scale wide; some appear as half-bands, those of one side not meeting exactly those of opposite side but all connected at midline; a series of small, black ventrolateral spots on parts of scales of row one and tips of adjacent ventrals, more or less set off by irregular white edges.

Ventral coloration black with flecks of white and light gray laterally; anterior ventrals lighter but heavily stippled with black and reddish brown. Tail gray to black with eight or 10 indistinct dark crossbands, underside black with small light flecks proximally; tip black, terminal scute dark brown at base, black at point.

Coloration after preservation little changed except for absence of reds and yellowish browns.

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* Dowling recount system, Copeia 1951(2):131–134.

Size and form: Adults of this species are generally smaller and more slender than those of *brevicaudus*. The head is narrower and the tail relatively longer. The largest male examined is the Sowerby specimen from South Manchuria, USNM 53365, total length 625 mm, tail 104 mm; the largest female, KU 38803, Pup'yong-ni, total length 610 mm, tail 90 mm. Juveniles 203–215 mm. Tail in males 15–17 (15.8) percent of total length, in females 12–15 (14.0) percent.

Habitat: The live specimens from Hanlon, as well as Daleske's material and that of Shannon (1956, p. 47) and of Webb et al. (1962, p. 170), represent both *brevicaudus* and *caliginosus*. Thus these forms are sympatric in a geographical sense but their ecological requirements, whether similar or different, are not clear.

Daleske's notes on a locality 8 miles west of Chorwon mention sandstone bluffs with an abundance of cold springs and small creeks, brush and vegetation, pine-oak woodland, some spruce, "very different from [Munsan-ni]." He collected both forms here and mentioned one sunning in a pine tree several feet above ground.

Shannon (loc. cit.) in reference to those collected northeast of Seoul (Kapyong, Kumhwa) mentions low, marshy environment provided by rice paddies or meandering streams; on lower slopes of hills but seldom to any considerable altitude. Those listed by Webb et al. (loc. cit., Seoul, Pup'yong-ni, Chip'o-ri) were collected "on brushy or wooded hillsides, along rock walls or in piles of rocks, and in damp, rocky, wooded ravines near streams."

Specimens collected by Dixon (1956, p. 56), all here referred to *caliginosus* (P'aiu-ri, near Munsan-ni) were found in or near streams. In a personal communication he characterized the vegetation of the area as scattered individual trees of Korean pine, clumps of Manchurian ash, Mongolian oak, Mono maple, and Scotch elm. "The lower gallery forest along the streams consists of many species of grasses, sedges, and an occasional Manchurian walnut and many poplar. The areas where *Agkistrodon* were taken are mainly stream edges where grasses are low and shrubs are common. Three specimens were taken from a 'den' in a rock wall along the stream. All were taken within 30 meters of water."

Stewart's specimen of *caliginosus*, from 5.8 miles southwest of Inje (1954, p. 67), was "on a very small loose rock and sand island in the middle of a shallow stream."

Range: Korea, from the Masan-Pusan area and Chejo-do (Quelpart Island) in the south to the extreme northeast of the peninsula above Ch'ongjin, and South Manchuria (Yalu River and Imienpo, North Kirin). Map 1.

Specimens examined: KOREA: Ch'ungch'ong-namdo Province—Mundong-ni [Mundung-ni ?], (6½ mi. NW), TNHC 18447; (9 mi. SE), TNHC 18444–5, 18450–1. Chiksan, CAS 31524–7. Ch'ungch'ong-pukto Province—Tanyang Pass, TNHC 18443, 18448. Hamgyong-pukto Province—Puryong, CAS 31537–9. Shoko [41° 56′ N, 129° 44′ E], CAS 31542. Hwanghae-namdo Province—Kaesong (14 mi. E), FMNH 188991.

Kaesong City—Kaesong, USNM 129605–6. Songdo (=Kaesong), FMNH 11469–73, 11475–6, 11478–83, 11485–92, 25237. Kangwon-do Province—Chorwon (8 mi. W), FMNH 188992–5. Inje (5.8 mi. SW), AMNH 72914. Kumhwa (23 mi. S), UIMNH 68749. Wonsan, CAS 31506–7, 31509–10, 31512. Kyonggi-do Province—Munsan-ni, TNHC 18452. P'aiu-ri (3 mi. SE Munsan-ni), CAS 87048–9, 87051–3, 87055; (7 mi. SE), CAS 87050, 87054. Pup'yong-ni (Central National Forest), KU 38801–4. 54 mi. NE Seoul, UIMNH 68748. Suwon (15 mi. ESE), TNHC 18442. Uijongbu (2 mi. N), FMNH 18896–9000. "Indianhead Camp" [35 mi. NE Seoul ?], USNM 136576. "Commonwealth" [on Imjin River, near P'anmunjom ?], USNM 136577. Kwangnung [= Kwangnung-mal ?], MVZ 61831. Kyongsang-namdo Province—Masan, TNHC 16182. Pusan City—Fusan (Pusan), CAS 31484; (1 mi. NE), KU 94567. Seoul City—AMNH 108508 [type]. Chejo-do Province (Quelpart Island)—TNHC 18439, 18449. Mosulpo, USNM 139890; (16 mi. NE), UMMZ 113465. Sogwi-ri (7 mi. NNE), UMMZ 113466. Korea, no locality—BMNH 1953.1.12.69; MVZ 66683; UMMZ 30525.

SOUTH MANCHURIA: Yalu River, about 180 mi. above mouth, USNM 52339 (Sowerby). Imienpo, North Kirin, USNM 53365 (Sowerby).

Agkistrodon saxatilis Emelianov

Brown Mamushi
Figures 3 and 4

Trigonocephalus intermedius Strauch, 1868, p. 295 (part); 1873, p. 245 (part).

Ancistrodon intermedius.—Nikol'skii, 1905, p. 326 (part).—Thompson, 1916, p. 62 (part).

Agkistrodon blomhoffii intermedius.—Stejneger, 1907, p. 464 (part).

Ancistrodon halys intermedius.—Nikol'skii, 1916, p. 276 (part); translation, 1964, p. 186.—Emelianov, 1929, p. 130 (part).

Agkistrodon blomhoffii brevicaudus.—Slevin, 1925, p. 99 (part).

Agkistrodon halys intermedius.—Maki, 1931, p. 209 (synonymy part), description and figure of Korean specimen, fig. 140 (not part).—Klemmer, 1963, p. 400 (part).

Ancistrodon halys stejnegeri Rendahl, 1933, p. 18 (part).

Ancistrodon saxatilis Emelianov, 1937, p. 26, figs. 1–4.

Type-locality: Vladivostok, Voroshilovo (Ussuriysk), and Suchan River (Emelianov, 1937, p. 30). Repository of types not clear; individual specimens of type-series not designated.

In describing this species, Emelianov carefully reviewed the works of Strauch, Nikol'skii, and others, including his own earlier studies (particularly *Snakes of the Far Eastern District*, 1929), examined a large number of specimens, including those in the Zoological Institute of the Academy of Sciences of the USSR, and made a highly convincing case for separating it from those with which it had long been confused.

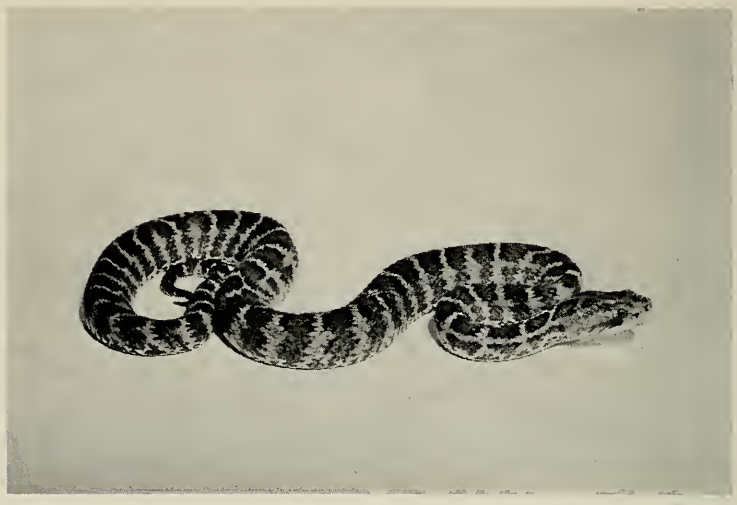


FIG. 3. *Agkistrodon saxatilis* Emelianov, vicinity of Seoul, South Korea. AMNH 108504. Photo by Isabelle Hunt Conant.

Unfortunately, he did not see the specimens of Strauch, 1868; he stated that they supposedly were lost at the time of a flood in Leningrad.

Emelianov's *saxatilis* seems to have been generally overlooked. In addition to the original paper, I have seen it mentioned in print only once: as a synonym of *intermedius* Strauch in Terent'ev and Chernov, 1965 (translation of Russian work of 1949). Although he listed only two specimens from Korea without specific localities, Emelianov included Korea in his statement of the range. In his meristic data, Tables I–III, the sexes and juveniles were separately listed, thus data from material examined by me can be readily and advantageously combined with his. My summaries of ventrals and subcaudals are so combined (Table 2 and Figs. 5 and 6). The diagnosis which follows, however, is based entirely on specimens examined by me, from Korea and USSR Maritime Territory (Vladivostok area north as far as Khabarovsk).

Diagnosis: Pattern of body a series of 29–44 irregular dark brown transverse bands (Table 1), 2–5 scales wide, each extending down sides to scale rows 1 or 2, separated by narrow lighter areas; belly light or dark gray, no distinct markings; crown and parietal region with indistinct, asymmetrical dark spots; a pair of elongate blotches curving laterally from the postparietal region to neck; cheek stripe relatively weak, not bordered above by a light line; tongue probably black in life; tip of tail and terminal spine dark.

Internasals not conspicuously narrow, their posterior margins approximately perpendicular to midline; loreals subquadrate, about as high as wide; preoculars 2; postoculars 2 (60%) or 3; supralabials 7 (61%) or 8;

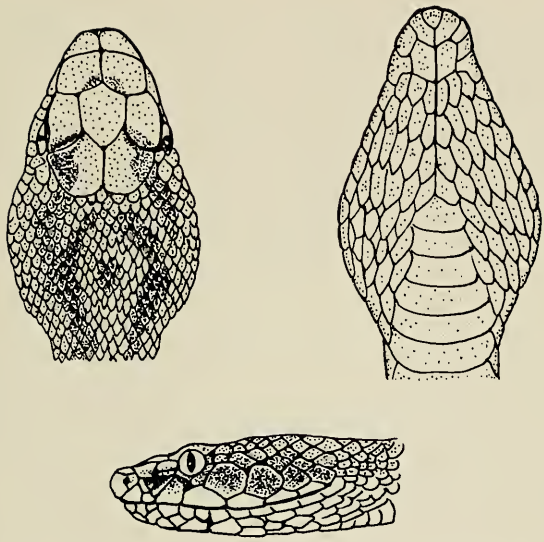


Fig. 4. *Agkistrodon saxatilis*, after Emelianov, 1937, fig. 1, p. 28.

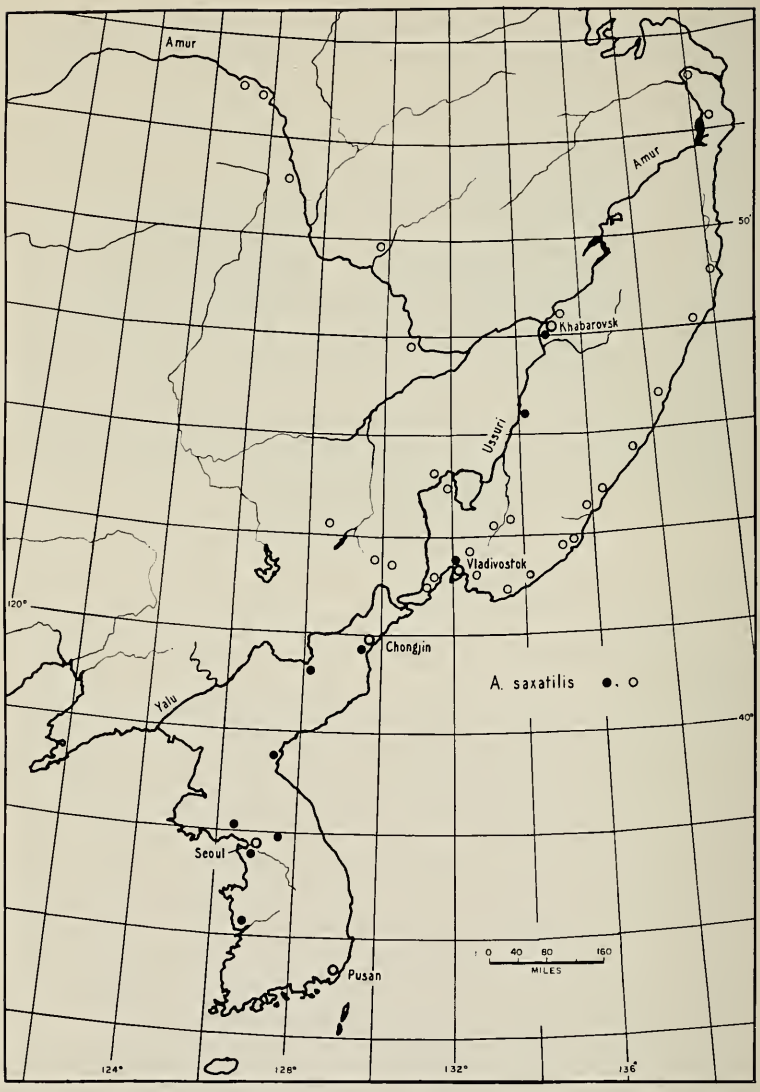
infralabials 10 (50%) or 11, last 3 or 4 supralabials conspicuously low and narrow.

Scale rows 23 at midbody, rarely 21, all strongly keeled except lowermost which are smooth or weakly keeled posteriorly; apical pits present, inconspicuous; ventrals 149–164 (154.4) in males, 148–165 (159.2) in females; subcaudals 37–48 (41.6) in males, 34–41 (37.4) in females.

Size and form: Adult individuals of this species are generally larger and more robust than those of *brevicaudus* and *caliginosus*. As recorded by Emelianov (op. cit., Tables I–III), the largest male, Pos'yet (just south of Vladivostok), was 790 mm in total length, tail 101 mm; largest female, Maytun, 695 and 82 mm; juveniles 210–250 mm. The largest seen by me, BMNH 89.12.16.140, male, Khabarovsk, is 780 mm in total length, tail 93. In specimens measured by me, the tail in males is 12–14 (13.0) percent of total length, in females, 11–12 (11.2) percent.

Habitat: The most typical habitat in the remote Ussuri taiga is the rocky taluses of the mountains, turned toward the sun [hence the name *saxatilis*]; also on the borders of the forest, along the banks of streams, between driftwood and windfallen trees and branches (Emelianov, 1937, p. 30).

Range: Far East, Manchuria and Korea, from the Pacific Coast west to the Great Khingan Range, north to the lower Amur River, south to Port Arthur on the Liaotung Peninsula (Emelianov, 1937, p. 26 and 40).



Map 2. Approximate locations with reference to *A. saxatilis*. Solid circles indicate localities of specimens examined in this study, open circles after Emelianov, 1937, Figure 4, page 31.

The southernmost specimen examined by me is from Mundong-ni, near the 36th parallel.

Specimens examined: KOREA: Ch'ungch'ong-namido Province—Chiksan, CAS 31528. Mundong-ni (6½ mi. NW), TNHC 18446. Hamgyong-pukto Province—Seishin (= Ch'ongjin), CAS 31540. Kaesong City—Songdo (= Kaesong), FMNH 11477, 11484. Kangwon-do Province—Wonsan, CAS 31511. Kyonggi-do Province—Kapyong, USNM 136575. Seoul City—AMNH 108501–7. Yanggang-do Province—Musan Pass (Yalu River), CAS 31543.

USSR: Khabarovsk, BMNH 89.12.16.140–141. Ussuri River, BMNH 75.10.14.1. Vladivostok, NMW 17088.

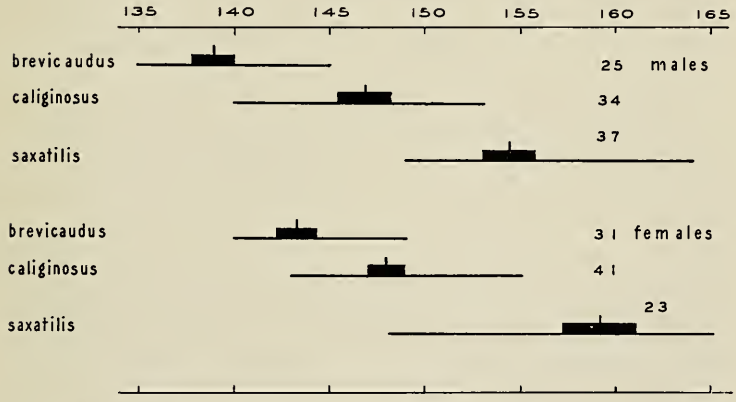


Fig. 5. Variation in the number of ventrals in the hypodigm of each of the three forms. The horizontal bar indicates the range of variation, the vertical bar the mean, and the black rectangles two standard errors on each side of the mean.

Variation

"Red" mamushis, or individuals with considerable red in their coloration, are frequently mentioned by authors and others who have seen numbers of these snakes in life. Erythrism is well known in *blomhoffii* in Japan and apparently occurs in both *brevicaudus* and *caliginosus* in Korea. From preserved specimens, however, it is impossible to assess the frequence of occurrence or degree of variation in this aspect of coloration.

No reference to variation in color was made by Shannon (1956), Webb et al. (1962), or by Dixon (1956), but two of Dixon's specimens (*caliginosus*) show traces of pink ventrally and along the sides, even after several years in preservative. Daleske's notes frequently refer to a "red phase" but no red remains in his preserved matrial. Hanlon's notes mention, and some of his color slides show, individuals with con-

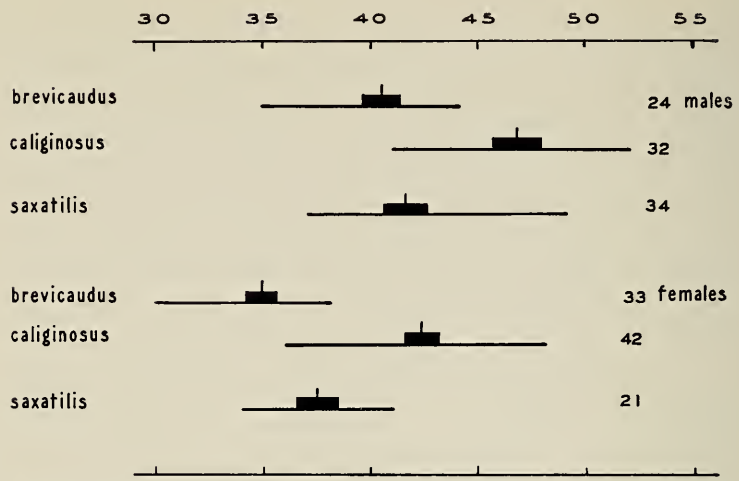


Fig. 6. Variation in the number of subcaudals in the hypodigm of each of the three forms. Symbols as in Figure 5.

siderable red ventrally and laterally, but I can not be certain of the form represented. None of his specimens that reached me alive was red. As to *saxatilis*, no red in the coloration was mentioned by Emelianov (loc. cit.), nor have I seen any indication of it in specimens examined.

Variation in the number of blotches (half-bands) or crossbands is similar in *brevicaudus* and *caliginosus* but the range is greater and the mean higher in *saxatilis* (Table 1).

In a few specimens of *caliginosus* (FMNH 11488–9, 11491, CAS 87049–50, 87055) the pattern of the body in part resembles that of *brevicaudus*. Some of the crossbands are divided at the midline and the resulting half-bands sometimes alternate. In the most divergent of these (CAS 87055) the pattern is distinct and the ground color, labials, and belly probably were red or pink in life. The divided crossbands of these specimens suggest hybridization, but in other features of coloration, and in scutellation and relative length of tail, all are readily referred to *caliginosus*.

The fact that *caliginosus* differs strikingly from *brevicaudus* not only in coloration but also in important meristic characters is indicated in the range and mean numbers of ventrals and subcaudals (Table 2, Figs. 5 and 6), and in the relatively long tail (Table 3). Differences in these characters are obvious in *saxatilis* also, but it is more closely allied with the *intermedius* complex; these data are presented here primarily as an aid to its discrimination from *caliginosus* and the subspecies of *blomhoffii*. It will be treated more fully in a monographic review of the genus.

KEY TO KOREAN FORMS OF *AGKISTRODON*

1. Scales in 23 rows; body pattern a series of dark crossbands extending down sides to scale rows 1 or 2 and separated by narrow lighter areas; cheek stripe not bordered above by a sharp light line; internasals with posterior margins nearly perpendicular to midline; last 3 or 4 supralabials notably low and narrow (Figs. 3 and 4) ..... *A. saxatilis* Emelianov

   Scales in 21 rows; internasals wider than long, posterior margins curving obliquely backward from midline; last 3–4 supralabials not unusually low and narrow 2

2. Body pattern of conspicuous pairs of subelliptical blotches, opposite or alternating, on a lighter ground color; cheek stripe bordered above and below with strong, sharply defined white lines (Fig. 1); loreals subquadrate, as high as wide; tongue black; tail relatively short, light at tip ..... *A. blomhoffii brevicaudus* Stejneger

   Body pattern of dark subrectangular crossbands extending down sides to scale row 2; ground color also dark; cheek stripe narrowly bordered with white lines above and below (Fig. 2); loreals subrectangular, notably wider than high; tongue pink; tail relatively long, dark at tip ..... *A. caliginosus* new species

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